CLAIMS

1. A nozzle plate, comprising:

a first nozzle layer having a first nozzle hole through which a liquid substance is discharged;

a second nozzle layer having a second nozzle hole that is connected to the first nozzle hole and receives the liquid substance; and

a blocking layer which is provided between the first nozzle layer and the second nozzle layer and has a higher resistance to etching than the first nozzle layer,

the blocking layer being locally formed around a connecting part at which the first nozzle hole is connected to the second nozzle hole.

2. The nozzle plate as defined in claim 1, wherein, the blocking layer has a higher resistance to etching than the second nozzle layer, and the blocking layer is larger in size than the second nozzle hole at the connecting part.

3. The nozzle plate as defined in claim 1 or 2, wherein, the first nozzle hole includes a part that penetrates the first nozzle layer and a part that penetrates the blocking layer.

4. The nozzle plate as defined in any one of claims 1-3,

wherein, the second nozzle hole has a tapered shape so as to be narrowed at the connecting part.

5. The nozzle plate as defined in any one of claims 1-4, wherein, the first nozzle layer and the second nozzle layer are made of a polymeric organic material, and the blocking layer is made of at least one material selected from the group consisting of a metal material, an inorganic oxide material, and an inorganic nitride material.

6. The nozzle plate as defined in any one of claims 1-5, wherein, the first nozzle layer and the second nozzle layer are made of polyimide resin, and the blocking layer is made of at least one material selected from the group consisting of Ti, Al, Au, Pt, Ta, W, Nb, SiO_2, Al_2O_3, and SiN.

7. The nozzle plate as defined in any one of claims 1-6, wherein, at least one of the first nozzle layer and the second nozzle layer is made of a material that predominantly includes at least one of Si, SiO_2, and Si_3N_4, and the blocking layer is made of a material that predominantly includes at least one of Al, Cu, Au, Pt, aluminum oxide, and aluminum nitride.

8. A nozzle plate, comprising:

a nozzle layer having at least one first nozzle hole that

discharges a liquid substance;

a reinforcing plate having a second nozzle hole that is connected to the first nozzle hole and receives the liquid substance, the reinforcing plate being fixed to the nozzle layer; and

a blocking layer which has a higher resistance to etching than the nozzle layer and is formed at least around a connecting part at which the first nozzle hole is connected to the second nozzle hole.

9. The nozzle plate as defined in claim 8, wherein, the blocking layer is formed inside an aperture of the second nozzle hole.

10. The nozzle plate as defined in claim 8 or 9, wherein, the first nozzle hole includes a part that penetrates the first nozzle layer and a part that penetrates the blocking layer.

11. The nozzle plate as defined in any one of claims 8-10, wherein, the nozzle layer is made of a polymeric organic material, the blocking layer is made of at least a material selected from the group consisting of a metal material, an inorganic oxide material, and an inorganic nitride material, and the reinforcing plate is made of at least a material selected from the group consisting of silicon, an inorganic

oxide material, and a polymeric organic material.

12. The nozzle plate as defined in any one of claims 8-11, wherein, the nozzle layer is made of polyimide resin, the blocking layer is made of at least one material selected from the group consisting of Ti, Al, Au, Pt, W, Nb, SiO_2, Al_2O_3, and SiN, and the reinforcing plate is made of either (i) a ceramic material mainly including at least one of silicon, glass and Al_2O_3, or (ii) polyimide resin.

13. The nozzle plate as defined in any one of claims 8-10, wherein, the nozzle layer is made of a material mainly including at least one of Si, SiO_2, and Si_3N_4, the blocking layer is made of a material mainly including at least one of Al, Cu, Au, Pt, aluminum oxide, and aluminum nitride, and the reinforcing plate is made of either (i) a ceramic material mainly including at least one of Si, glass, and Al_2O_3, or (ii) polyimide resin.

14. A manufacturing method of a nozzle plate having a first nozzle hole through which a liquid substance is discharged,

the manufacturing method comprising the steps of:

(i) forming a nozzle layer for forming the first nozzle hole;

(ii) locally forming a blocking layer on the nozzle layer, the blocking layer having an opening that is a part of the first nozzle hole, and the blocking layer functioning as an etching mask used for forming the first nozzle hole; and

(iii) forming a first nozzle hole that penetrates the nozzle layer from the opening, the first nozzle hole being formed by etching, using the blocking layer as the etching mask, the nozzle layer through the opening.

15. The manufacturing method as defined in claim 14, further comprising the step of:

(iv) connecting, with the nozzle layer, a reinforcing plate which is independently formed and has a second nozzle hole, the step (iv) being performed after the steps (i)-(iii).

16. A manufacturing method of a nozzle plate having a nozzle hole through which a liquid substance is discharged,

the manufacturing method comprising the steps of:

(i) forming a first nozzle layer for forming a first nozzle hole:

(ii) locally forming a blocking layer on the nozzle layer, the blocking layer having an opening that is a part of the first nozzle hole, and the blocking layer functioning as an etching mask used for forming the first nozzle hole; and

(iii) on the first nozzle layer and the blocking layer,

forming a second nozzle layer for forming a second nozzle hole;

(iv) forming the second nozzle hole that reaches the blocking layer, by etching and penetrating the second nozzle layer; and

(v) forming a first nozzle hole that penetrates the first nozzle layer, by etching, using the blocking layer as the etching mask, the first nozzle layer through the opening.

17. The manufacturing method as defined in claim 16, wherein, the steps (iv) and (v) are successively carried out.

18. A nozzle plate, comprising:

a first nozzle layer having a first nozzle hole through which a liquid substance is discharged;

a second nozzle layer having a second nozzle hole that is connected to the first nozzle hole and receives the liquid substance; and

a discharge layer that has an opening and has a higher resistance to etching than the first nozzle layer, the discharge layer being provided on a liquid substance discharging side of the first nozzle layer, and

the first nozzle hole penetrating the first nozzle layer and being connected with the opening.

19. The nozzle plate as defined in claim 18, wherein, the discharge layer is formed in the first nozzle layer.

20. The nozzle plate as defined in claim 18, wherein, the discharge layer is predominantly made of an inorganic material.

21. The nozzle plate as defined in claim 18, wherein, that part of the first nozzle layer where the nozzle hole penetrates is a first nozzle hole part, and an outer shape of the discharge layer is larger than an outer shape of the first nozzle hole part at an interface between the discharge layer and the first nozzle layer.

22. The nozzle plate as defined in claim 18, wherein, the discharge layer is locally formed around the opening.

23. The nozzle plate as defined in claim 18, wherein, between the first nozzle layer and the second nozzle layer, a blocking layer which has a higher resistance to etching than the first nozzle layer is locally formed, and the first nozzle hole penetrates the blocking layer and is connected to the second nozzle hole.

24. The nozzle plate as defined in claim 23, wherein, the

blocking layer has a higher resistance to etching than the second nozzle layer, and an outer shape of the blocking layer is larger than an outer shape of the second nozzle hole at a connecting part at which the first nozzle hole is connected to the second nozzle hole.

25. The nozzle plate as defined in claim 18, wherein, the first nozzle layer has a higher resistance to etching than the second nozzle layer.

26. The nozzle plate as defined in claim 18, wherein, a first nozzle hole part that penetrates the first nozzle layer is taper-shaped so that a connecting part at which the first nozzle hole part contacts the opening is narrow.

27. The nozzle plate as defined in claim 18, wherein, the second nozzle hole is taper-shaped so that a connecting part where the second nozzle hole contacts the first nozzle hole is narrow.

28. The nozzle plate as defined in claim 18, wherein, a liquid repellent film is formed at least on a liquid substance discharge side of the discharge layer.

29. A nozzle plate, comprising:

a first nozzle layer having a first nozzle hole through which a liquid substance is discharged;

a reinforcing plate having a second nozzle hole that is connected to the first nozzle hole and receives the liquid substance, the reinforcing plate being fixed to the first nozzle layer;

a blocking layer which has a higher resistance to etching than the first nozzle layer and is formed at least around a connecting part at which the first nozzle hole is connected to the second nozzle hole; and

a discharge layer which has an opening, has a higher resistance to etching than the first nozzle layer, and is formed so as to contact a liquid substance discharge side of the first nozzle layer,

the first nozzle hole penetrating the first nozzle layer and being connected with the opening.

30. The nozzle plate as defined in claim 18, wherein the discharge layer is made of a material mainly including at least one of Al, Pt, Au, Al_2O_3, and AlN, the first nozzle layer is made of a silicon compound, and the second nozzle layer is made of organic resin.

31. The nozzle plate as defined in claim 18, wherein, the discharge layer is made of a silicon compound, the first nozzle

layer is made of a metal material mainly comprising aluminum, and the second nozzle layer is made of organic resin.

32. The nozzle plate as defined in claim 23, wherein, the first nozzle layer is made of organic resin, and the discharge layer is made of a material that mainly includes at least one of Ti, Al, Au, Pt, Ta, W, Nb, SiO_2, Al_2O_3, Si_3N_4, and AlN.

33. The nozzle plate as defined in claim 23, wherein, the first nozzle layer is made of a material mainly including at least one of Si, SiO_2, and Si_3N_4, and the discharge layer is made of a material mainly including at least one of Al, Ni, Fe, Co, Cu, Au, Pt, aluminum oxide, and aluminum nitride.

34. A manufacturing method of a nozzle plate including a first nozzle layer that has a first nozzle hole including a first opening and a first nozzle hole part,

the method comprising the steps of:

(i) forming a discharge layer where the first opening is formed, the discharge layer having a higher resistance to etching than the first nozzle layer;

(ii) forming a first nozzle layer that fills the first opening and covers the discharge layer;

(iii) forming the first nozzle hole part in the first nozzle

layer, in line with a position where the first opening is formed; and

(iv) removing a part of the first nozzle layer by etching, the part being in the first nozzle hole part.

35. The manufacturing method as defined in claim 34, further comprising the steps of:

(v) forming a second nozzle layer in such a manner as to fill the first opening and the first nozzle hole part and to cover the first nozzle layer, the second nozzle layer having a lower resistance to etching than the first nozzle layer; and

(vi) forming, by etching the second nozzle layer, a second nozzle hole that penetrates the second nozzle layer,

the steps (v) and (vi) being performed after the step (iv).

36. The manufacturing method as defined in claim 34, further comprising the steps of:

(vii) locally forming a blocking layer on the first nozzle layer in such a manner as to correspond to the first opening, the blocking layer having a second opening and having a higher resistance to etching than the first nozzle layer and the second nozzle layer; and

(viii) forming a second nozzle layer that fills the second opening and covers the first nozzle layer, and then forming, by etching the second nozzle layer, a second nozzle hole that

penetrates the second nozzle layer and reaches the blocking layer,

the steps (vii) and (viii) being performed between the step (ii) and (iii).

37. The manufacturing method as defined in claim 35, further comprising the steps of:

(ix) removing a part of the second nozzle layer, the part being in the first nozzle hole part; and

(x) removing a part of the second nozzle layer, the part being in the first opening,

the steps (ix) and (x) being performed following the step (vi).

38. The manufacturing method as defined in claim 36, wherein, the steps (iii) and (iv) are performed following the step (viii).

39. The manufacturing method as defined in claim 34, further comprising the steps of:

(xi) forming a liquid repellent film having a lower resistance to etching than the discharge layer, at least on a surface of the discharge layer; and

(xii) removing a part of the liquid repellent film by performing etching from an opposite side of the first opening,

the part being in the first nozzle,

the steps (xi) and (xii) being performed after the steps (i)-(iv) .